Phys 131 2016

Lecture 11

Weds: Review I

Thurs: Seminar WS 117
12:30

Fri: Exam I Ch 1 → Ch 4

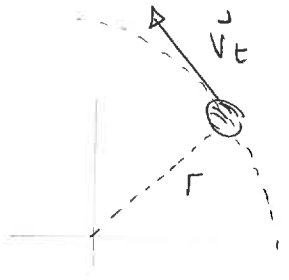
Physics question

Does physics only apply to Earth?

- same laws describe observable astrophysical phenomena
- satellites using electronics / optics / other mechanical devices work in space

Tangential and angular velocity

Angular velocity describes the rate at which angular position changes. This can be related to the conventional velocity of an object. In this case the conventional velocity is called the tangential velocity $\vec{v}_t$ and a simple geometric derivation gives:



$$\boxed{v_t = \omega r}$$

where r is the radius of orbit and ω is the angular velocity

Uniform circular motion

If an object moves:

1) in a circle (with constant radius)

2) at a constant speed

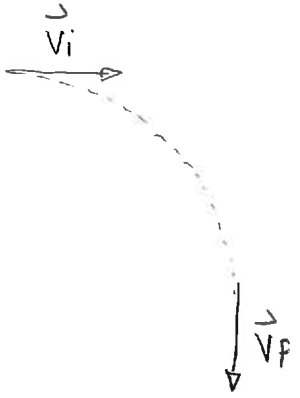
then we describe its motion as uniform circular motion.

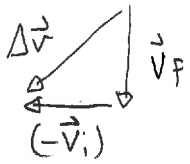
Warm Up 1 (orig 2)

The velocity vector constantly changes direction so acceleration is not zero. One can use

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

to show that $\Delta \vec{v}$ points radially inward. Determining the magnitude is more involved. We can show that

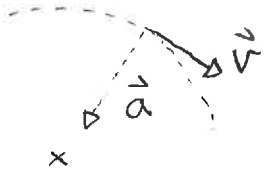




For uniform circular motion acceleration points radially inward and has magnitude

centripetal accel. → $a_c = \frac{v^2}{r}$

where r is the radius of orbit.



Quiz 1

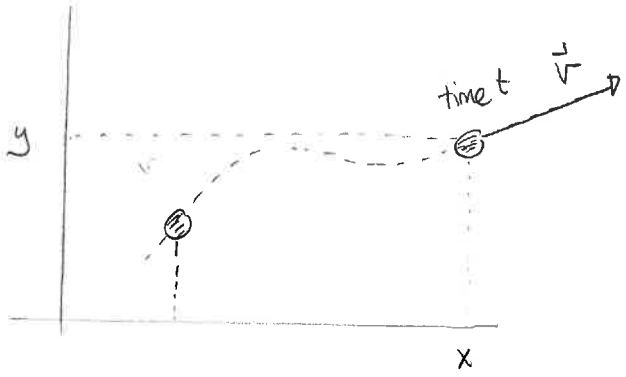
Quiz 2

See challenging questions in Supp Ex 25, 26

General scheme of classical physics

Kinematics describes motion in terms of various physical quantities, such as position, velocity and acceleration and provides a framework for relating these

The scheme is usually described as progressing from position information, eventually giving acceleration.



know position at all times: $x(t), y(t)$ → differentiate → velocity at all times $v_x = \frac{dx}{dt}$ $v_y = \frac{dy}{dt}$ → differentiate → acceleration at all times $a_x = \frac{dv_x}{dt}$ $a_y = \frac{dv_y}{dt}$

However the order can be reversed

know acceleration at all times; know velocity at initial instant → integrate → get velocity at all times → integrate → get position at all later instants; know position at initial instant

know a_x, v_{ix}

$v_{fx} = v_{ix} + a_x \Delta t$

x_i

$x_f = x_i + v_{ix}\Delta t + \frac{1}{2}a_x \Delta t^2$

The central issue in physics is to determine acceleration without already knowing velocity or position.

Dynamics

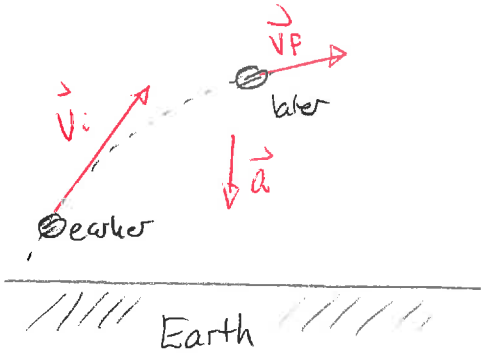
Kinematics only describes the state of motion of an object and how (but not why) the state of motion evolves. In more sophisticated treatments of mechanics.

> The state of motion of an object is described by its velocity (relative to a particular type of observer)

If we ask what changes the state of motion of an object we are asking what changes the velocity of an object. Or more precisely

> What causes / produces acceleration? What acceleration occurs in various situations?

Consider a projectile near Earth's surface. Observation shows that the velocity changes with time Thus the projectile has non-zero acceleration. Experiments and observations show that the acceleration points down. What causes this?



We suspect that the Earth is responsible. More specifically we assume that Earth interacts with the projectile and this produces acceleration. This is an example of the general scheme in mechanics.

Other objects interact with object of interest. → (dynamics) → Interaction produces acceleration → (Kinematics) → Acceleration describes velocity changes ⇝ gives future velocity + position

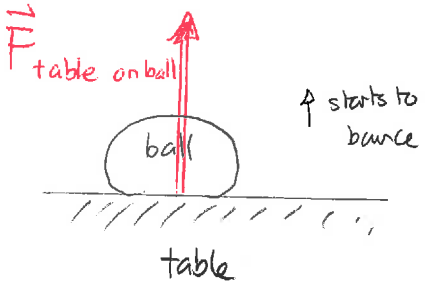
Earth interacts with projectile.

Acceleration $\vec{a}$ ↓ $9.8 m/s^2$

The heart of classical physics is in describing how acceleration is produced.

Forces

Interactions between objects will be described via a mathematical quantity called a force. The general scheme is illustrated by the example of a ball bouncing off a surface. The process is:



1) identify the object in whose motion one is interested e.g. ball

2) identify other object that interacts with the object of interest. e.g. table

3) specify a force vector with

   a) magnitude = strength of push/pull

   b) direction = direction of push/pull

Demo: PhET Forces in 1 dimension

* setting: friction OFF
  total force OFF

Quiz 3 → (No vectors)

* push + release ~> observe applied force vector
  ~> observe velocity graph

↳ now show vectors

We say:

Object B exerts (type) a force on object A